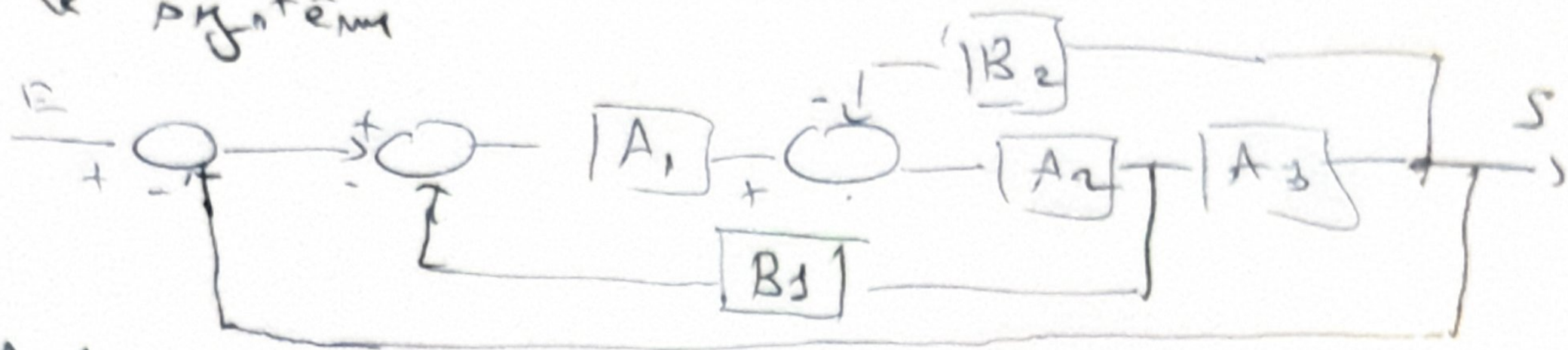
Corrigé-type de l'examin

Asservissement et Régulation des systèmes

Exercice 01 : (07)

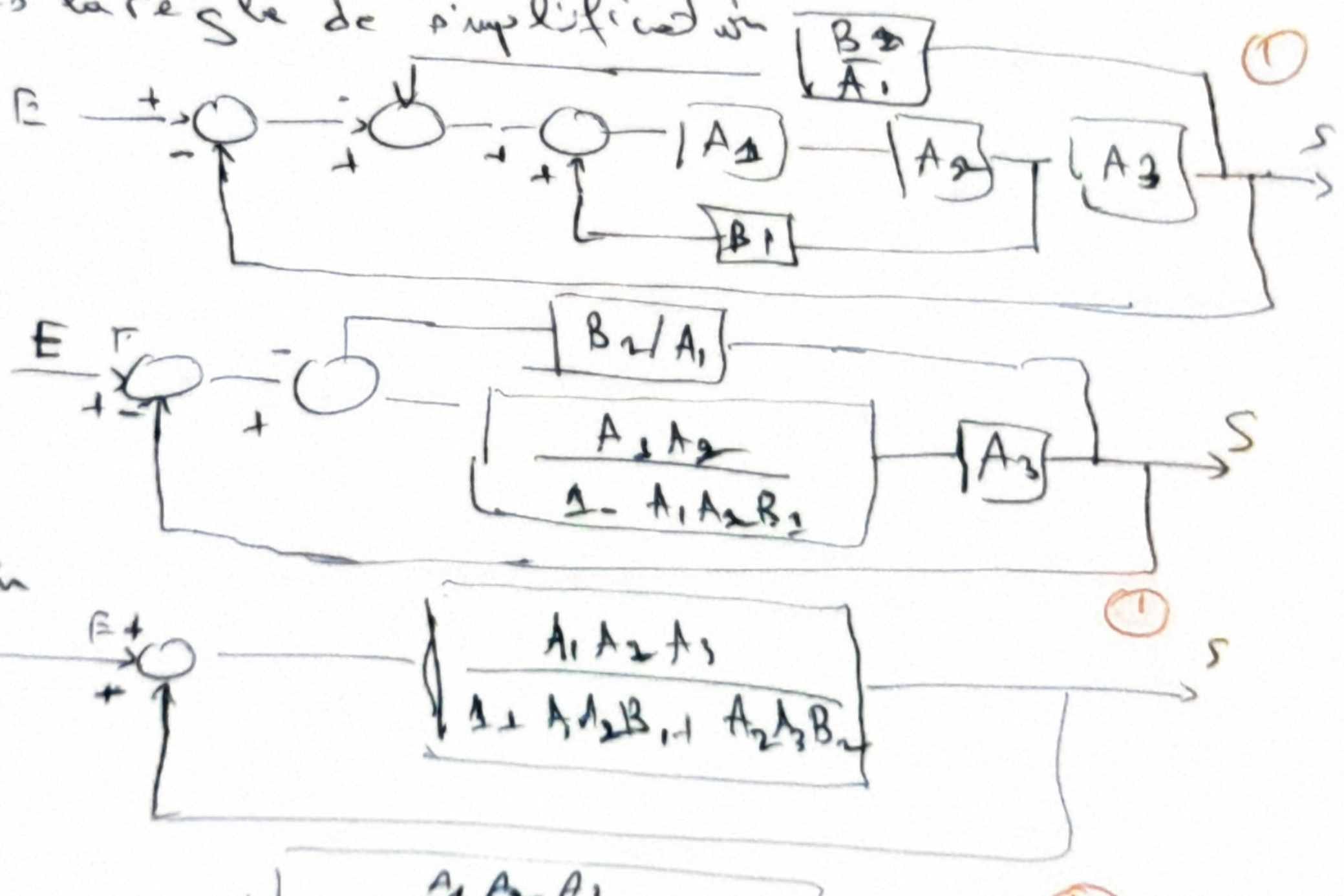
Soit le système



a/- simplifié le système pour obtenir :

$$F(p) = \frac{S(p)}{E(p)}$$

d'après la règle de simplification



2. a- L'équation caractéristique :

$$F(S) = \frac{S(S)}{E(S)} = \frac{K}{S^2 + 3,6S + K}$$ (1)

b- Les valeurs de pulsation naturelle « ω_n » et le coefficient « ξ » d'un système de 2ème ordre

$$F(S) = \frac{S(S)}{E(S)} = \frac{1}{\frac{1}{\omega_n^2}S^2 + \frac{2\xi}{\omega_n}S + 1}$$ (1)

c- $F(S) = \frac{S(S)}{E(S)} = \frac{36}{S^2 + 3,6S + 36}$

Donc : • la pulsation naturelle : $\omega_n = 6 rd/s$ (1)

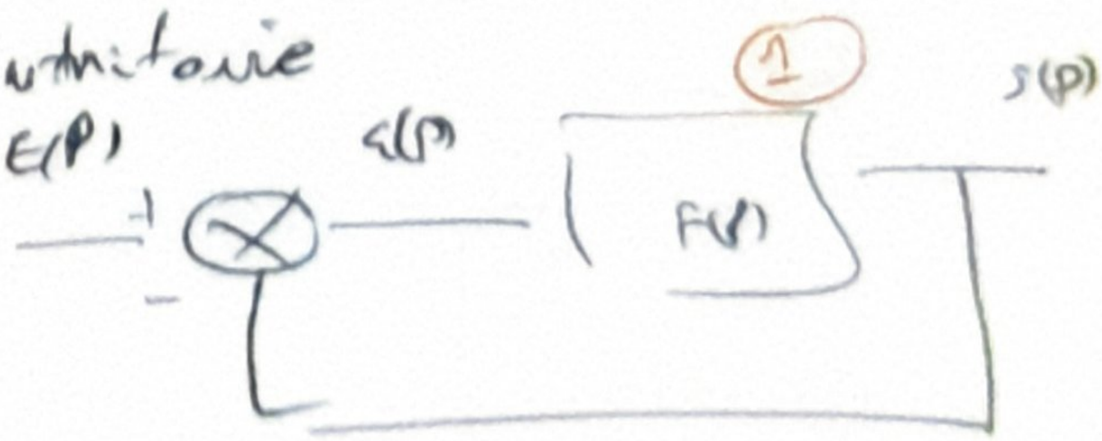
• le coefficient ξ : $\xi = 0,3$ (1)

Exercice 02 (06)

On considère

$$F(S) = \frac{K}{S(S+1)(S+2)} \quad / \quad K > 0$$

On boucle le SNI à retour unitaire



$$G(S) = \frac{F(S)}{1 + F(S)} = \frac{\frac{K}{S(S^2+3S+2)}}{1 + \frac{K}{S(S^2+3S+2)}} = \frac{K}{S(S^2+3S+2)+K}$$ (1)

Le dénominateur de la fonction de transfert en BF est

$$S(S^2+3S+2)+K = S^3 + 3S^2 + 2S + K$$ (1)

- On appliquant le critère de stabilité de Routh :

1	2
3	K
6-K	0
3	0

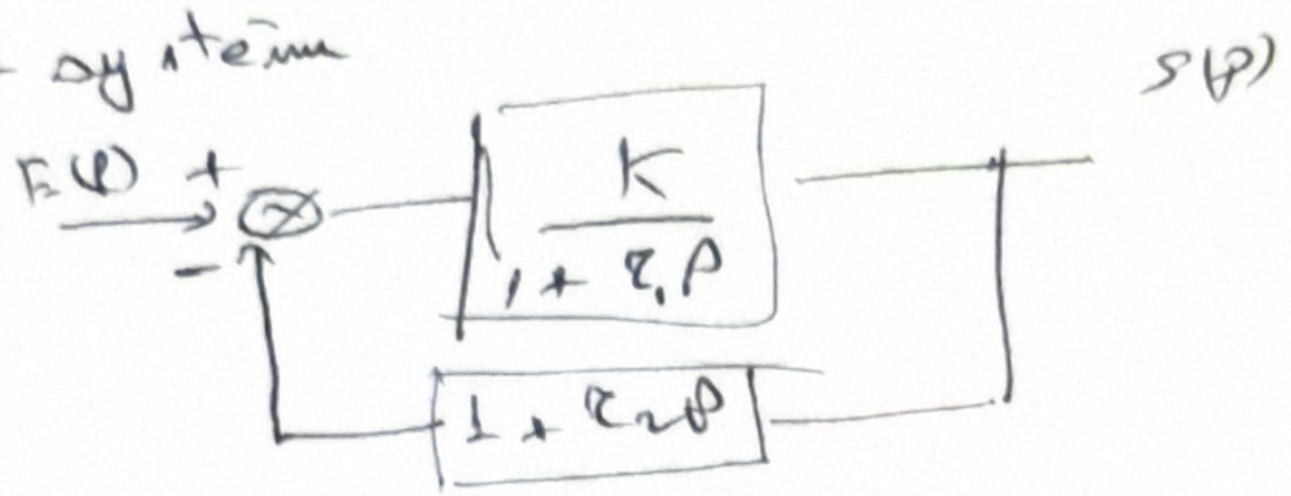
(2)

6 - K > 0 le système est stable donc :

0 < K < 6 (1)

Exercice 03 (07)

Soit le système



déterminer :

1). la fonction de transfert en boucle fermée $H_{BF}(p)$

$$H_{BF} = \frac{\frac{K}{1+\tau_1 p}}{1 + (1+\tau_2 p)\left(\frac{K}{1+\tau_1 p}\right)}$$

$$H_{BF} = \frac{K}{1 + \tau_1 p + K(1+\tau_2 p)} = \frac{K}{(\tau_1 + K\tau_2)p + K + 1}$$ (2)

2). c'est un système du 1er ordre ($n = 1$) (1)

par identification avec la forme canonique d'un système du 1er ordre : $H_{BF}(p) = \frac{K_{BF}}{1 + \tau_{BF} p}$

$$H_{BF}(p) = \frac{K}{(K+1)\left(\left(\frac{\tau_1 + K\tau_2}{1+K}\right)p + 1\right)} = \frac{\cancel{K}/(K+1)}{1 + \left(\frac{\tau_1 + K\tau_2}{K+1}\right)p}$$

$$K_{BF} = \frac{K}{K+1} \quad , \quad R_{BF} = \frac{R_1 + K R_2}{K+1}$$

Application Numérique

$$K_{BF} = \frac{4}{4+1} = \frac{4}{5} \quad (1)$$

$$, \quad R_{BF} = \frac{1 + (\frac{1}{4})4}{4+1} = (2/5) = 0,4\ \Omega \quad (1)$$

(2) La réponse indicielle. $E(p) = \frac{1}{p}$

$$\frac{S(p)}{E(p)} = \frac{(4/1)}{1 + (\frac{2}{5})p} = \frac{4}{5+2p}$$

$$S(p) = \frac{4}{2p+5} \qquad E(p) = \frac{4}{p(2p+5)}$$

$$S(p) = \frac{A}{p} + \frac{B}{(2p+1)}$$

on obtient :

$$A = \frac{4}{5} \quad (1) \quad , \quad B = -\frac{8}{5} \quad (1)$$

donc :

$$S(p) = \frac{(4/5)}{p} - \frac{(8/5)}{5+2p} = \frac{(4/5)}{p} - \frac{(4/5)}{p + (\frac{5}{2})}$$

$$s(t) = L^{-1}(S(p)) = \frac{4}{5} - \frac{4}{5} e^{-5/2t} = \frac{4}{5}\left(1 - e^{-5/2t}\right)$$

(1)

corrigé type Plan d'expériences 2025-2026 M2GPC

- Partie I QCM : 0,75 x 8

Q1 : a X, b, c	Q3 : a, b X, c X	Q5 : a, b X, c	Q7 : a X, b, c
Q2 : a, b X, c	Q4 : a, b, c X	Q6 : a, b, c X	Q8 : a, b, c X

Problème :

I) $a_0 = 16,8125$, $a_1 = 3,3125$, $a_2 = 1,8125$, $a_3 = 2,3125$, $a_{12} = 0,5625$, $a_{13} = 0,5625$
$a_{23} = 0,5625$, $a_{123} = 0,0625$ 0,25 x 8

$y_{modèle}$:

$Y_1 = 11,0625$, $Y_2 = 15,4375$, $Y_3 = 12,4375$, $Y_4 = 19,0625$, $Y_5 = 13,4375$
$Y_6 = 20,0625$, $Y_7 = 17,0625$, $Y_8 = 25,9375$ 0,25 x 8

$e_i = 0,0625 \Rightarrow e_i^2 = 0,00390625$ 0,25

$S^2 = 0,03125$, $S_i^2 = 0,00390625$, $S = 0,0625$ 0,25 x 3 ; $t_i = \frac{|a_i|}{S}$

$t_0 = 269 \to S$, $t_1 = 53 \to S$, $t_2 = 29 \to S$, $t_3 = 37 \to S$, $t_{12} = 9 \to NS$, $t_{13} = 9 \to NS$
0,25 x 4

$t_{23} = 9 \to NS \Rightarrow y_{modèle} = 16,8125 + 3,3125\,A + 1,8125\,B + 2,3125\,C$ 0,25

II) A = 65 (codé) $\to$ A = 0, B = 17 min (codé) $\to$ B = 0,4, C = 6,55 (codé) $\to$ C = 0,55 $\Rightarrow y = 18,8094$ 0,25 x 4

IC : [16,0184 ; 17,6066], [2,5184 ; 4,1066], [1,0184 ; 2,6066], [1,5184 ; 3,1066]
[−0,2316 ; 1,3566], [−0,2316 ; 1,3566), [−0,2316 ; 1,3566) 0,25 x 7

ANOVA : $F_{obs} = 877$, $F_{crit} = 254$ donc on accepte la linéarité du modèle. 0,25 0,25 x 3

$R^2 = 0,9998$ $R^2_{adj} = 0,9987$ 0,25 x 2

III) → 0,4 ; 1,3 ; 1,54 ; 1,72 ; 1,84 ; 1,88 ; 1,90 ; 1,94 ; 1,98 0,25

$\bar{x} = 1,6111$, $v = 0,25064$, $\sigma = 0,50064$, $R_1 = 0,5696$, $R_N = 0,1253$ 0,25 x 5

Donc x_1 est une valeur aberrante $R_1 > R_N$ donc 0,4 à éliminer. 0,25

$\bar{x}^* = 1,7625$, $v^* = 0,0546$, $\sigma^* = 0,2338$, $R_1^* = 0,353$, $R_N^* = 0,059$ 0,25 x 5

Corrigé type du Contrôle de l'optimisation 2015/2016

Q:1 [faux] (0,25)

pour toute valeur de $a \in]-2, +2[$. (0,75)

Q:2 [faux] (0,25)

$f'(x_a) \times f'(x_b)$ et la méthode de la sécante . (0,75)

Q:3 [faux] (0,25)

$L_k = F_{n-(k-1)} \times L_1$ (0,75)

Q:4 [faux] (0,25)

La réduction pour la méthode de la section d'Or est:

$R_{GS} = (K)^{1-1} = (1,6180\,34)^{1-1}$ (0,75)

Q:5 [faux] .

c'est un minimum et la fonction est convexe .

Corrigé type du Contrôle de L'optimisation 2025/2026

Solution d'exercice 1

1) $f(x) = (1-2*x)^4$ x_1=0, x_2=0.5, x_3=2

1ère itération :

$$x^* = \frac{1}{2}\frac{[(x_2^2 - x_3^2) \times f(x_1) + (x_3^2 - x_1^2) \times f(x_2) + (x_1^2 - x_2^2) \times f(x_3)]}{[(x_2 - x_3) \times f(x_1) + (x_3 - x_1) \times f(x_2) + (x_1 - x_2) \times f(x_3)]}$$

$$f(x_1) = 1, f(x_2) = 0, f(x_3) = 81$$

x^*= 0.285714 et f(x^*) = 0.033736

2ème itération : On éliminer le point x3 car il donne la plus grande valeur de la fonction donc

x_1=0, x_2=0.285714, x_3=0.5, f(x1)= 1, f(x2)= 0.033736, f(x3)= 0

x^*= 0.405062 et f(x^*) = 0.001299

Solution d'exercice 2

1- $\nabla f(x, y) = \begin{bmatrix} 4x - 8y^2 \\ -16xy - 16y^2 + 16y \end{bmatrix}$; $H(x, y) = \begin{bmatrix} 4 & -16y \\ -16y & -16x - 32y + 16 \end{bmatrix}$.

2- $\nabla f(x, y) = \begin{bmatrix} 0 \\ 0 \end{bmatrix} \Leftrightarrow x = 2y^2$ et $xy + y^2 - y = 0 = 2y^3 + y^2 - y = y(2y-1)(y+1)$.

Les points stationnaires sont : (0, 0),(1/2, 1/2) et (2, -1).

$H(0, 0) = \begin{bmatrix} 4 & 0 \\ 0 & 16 \end{bmatrix}$: $4 > 0$ *et* $\det(H(0, 0)) > 0$; $\Rightarrow$ (0,0) est un minimum local.

$H(\frac{1}{2}, \frac{1}{2}) = \begin{bmatrix} 4 & -8 \\ -8 & -8 \end{bmatrix}$: $\det(H(\frac{1}{2}, \frac{1}{2})) < 0$ $\Rightarrow$ $(\frac{1}{2}, \frac{1}{2})$ est un point selle.

$H(2, -1) = \begin{bmatrix} 4 & 16 \\ 16 & 16 \end{bmatrix}$: $\det(H(2, -1)) < 0$; $\Rightarrow$ (2, −1) est un point selle.

Solution d'exercice 3

1- Identification des variables de décision, qui sont : X et Y
2- Identification de la fonction Objectif : Maximiser S=XY (1)
3- D'après les données : P=2X+Y=100 (2)
4- Choisir une méthode de résolution (on va choisir une méthode analytique).
A partir de l'équation (2) on a : Y=100-2X (3)
En remplaçant l'équation (3) dans l'équation (1), on obtient : S=X(100-2X) (4)
Alors la fonction objectif se réécrit sous la forme :
$f(X)=100X-2X^2$ (5)
Pour trouver la valeur maximale x* de f(x) on va avoir $f'(x^*)=0$
$f'(X^*)=100-4X=0$ (6)
Enfin, on va obtenir : X^*=25 m et Y^*=50m
La surface maximum à clôturer est : $S^*=X^*Y^*$=1250 m^2

Université Larbi Ben M'hidi Oum El Bouaghi
Département de Génie des Procédés
Module : Biomasse et Biocarburants
Niveau : Master 1 Génie Chimique

10/01/2025

Durée : 1h30

Corrigé type

Exercice I : (8 points)

La biomasse est reconnue comme une source d'énergie propre et renouvelable possédant un potentiel important pour remplacer les combustibles fossiles.

1. **Définir :**

- **La biomasse selon l'écologie:**

La biomasse est l'ensemble de la matière organique d'origine végétale ou animale présente dans un espace fini, un biotope par exemple, à un instant t. **(1.5 pts)**

- **Bioénergie:**

Dans le domaine de l'énergie, le terme de biomasse regroupe **l'ensemble des énergies provenant de la dégradation de la matière organique.** La biomasse énergie fait référence à la **matière organique qui peut être utilisée comme source d'énergie**. On parle de bioénergie. **(1.5 pts)**

2. **Citer** les types de la biomasse selon sa transformation en combustible:

La biomasse est un combustible difficilement exploitable dans son état brut. Sa transformation permet d'obtenir des combustibles plus intéressants sous forme :

- solide comme les pellets, les plaquettes, les semi-cokes, cokes, charbon de bois, etc … **(1. pt)**
- liquide comme l'éthanol, le biodiesel, les huiles pyrolytiques. **(1pt)**
- gazeuse comme les gaz de décharge, le biogaz, le gaz de bois ou d'autres résidus utilisables dans des moteurs, chaudières ou turbines. **(1pt)**

3. **Expliquer :** La biomasse est une réserve d'énergie considérable née à l'action du soleil grâce à la photosynthèse:

Elle existe sous forme de carbone organique. Sa valorisation se fait par des procédés spécifiques selon le type de constituant.

Elle est issue directement ou indirectement de la photosynthèse chlorophyllienne dont la réaction de base s'écrit de manière simplifiée et si l'on ramène à l'atome de Carbone :

$CO_2 + H_2O$ + éléments minéraux + énergie lumineuse = biomasse + O_2 **(2pts)**

Exercice II :(12 points)

On appelle les biocarburants les carburants produits à partir de matières végétales ou animales fossiles.

1. **Définir :**

Biodiesel: Le biodiesel est un carburant qui peut être utilisé pur et/ou mélangé dans le gazole pour les moteurs Diesel. Il est constitué d'esters méthyliques d'huiles végétales (EMHV), eux-mêmes provenant d'huiles végétales (tournesol, colza, palme, soja, etc.).**(1.5 pts)**

- **bioéthanol cellulosique:** La voie biochimique désigne la filière de valorisation de la biomasse lignocellulosique par hydrolyse puis fermentation. Le produit final principal est l'éthanol dit «cellulosique». **(1.5 pts)**

2. **Expliquer :** Le bioéthanol de première génération peut être produit par deux façons différentes à partir de la biomasse:

- Par fermentation. **(1.5 pts)**
- Par hydrolyse suivi d'un procédé de fermentation. **(1.5 pts)**

3. **Citer :** Les procédés de production des carburants de deuxième génération:

Deux grandes voies technologiques sont capables de valoriser plus ou moins complètement ces polymères : la **voie biochimique** (hydrolyse et fermentation) qui permet la production d'éthanol et la **voie thermochimique** (thermolyse et synthèse) **(2 pts)**

4. **Expliquer :** la filière de valorisation de la matière lignocellulosique par gazéification puis par synthèse ? Expliquer brièvement:

B. Voie thermochimique

La voie thermochimique ou **BTL** (Biomass To Liquid) désigne la filière de valorisation de la biomasse lignocellulosique par gazéification puis synthèse. Le produit final peut être du diesel, du DME (diméthyléther), du méthanol ou encore de l'éthanol. **(2 pts)**

5. **Expliquer :** Pourquoi la lignine dans les carburants de deuxième génération ne peut pas être fermentée en éthanol :

la lignine ne peut pas être fermentée en éthanol. Seules les fractions cellulosiques et hémicellulosiques sont des sources potentielles de sucres fermentescibles, respectivement de glucose et de pentoses .**(2 pts)**

Bonne Chance

Subject: Process engineering Simulations: Aspen hysys Grade: 1st MGP

Academic Year: 2024-2025 Date : 15/01/2026

Final Exam

Exercise 01: (Use SRK Fluid Pkg)

The objective is to separate a mixture of five paraffins into light and heavy fractions using a distillation column equipped with 12 trays, a full reflux condenser, and a kettle reboiler. The feed stream, with a flow rate of 1000 lbmol/hr, consists of 3% ethane, 20% propane, 37% n-butane, 35% n-pentane, and 5% n-hexane (on a mole basis). The feed enters the column at the 8th tray, counting from the top, at a temperature of 225°F and a pressure of 250 psia. The condenser operates at a pressure of 248 psia, while the reboiler pressure is set at 252 psia. The initial design specifications stipulate a reflux ratio of 6.06 and a vapor overhead product flow rate of 226 lbmol/hr. Subsequently, the design is revised to achieve an overhead propane flow rate of 191 lbmol/hr and a bottom flow rate of 365 lbmol/hr for n-butane.

1. Present the process flow schematics.
2. Report the composition of the distillation column outlet streams.
3. Compare the condenser and reboiler temperatures, as well as the reflux ratio, before and after the modification

Exercise 02: (Use Peng Robinson Fluid Pkg)

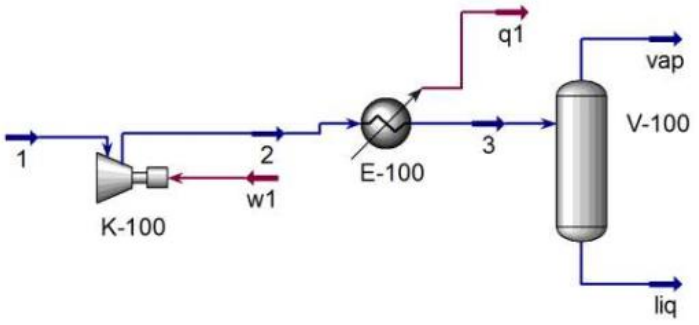


Figure 1 Process flow schematic Exercise 02

A feed stream containing 15 mol% ethane, 20 mol% propane, 60 mol% isobutane, and 5 mol% n-butane is available at 50 °F and atmospheric pressure at a flow rate of 100 lbmol/h. The stream is to be compressed to 50 psia and subsequently cooled to 32 °F. The resulting two-phase mixture is then to be separated into vapor and liquid product streams. Pressure drop across the condenser is assumed negligible.

1. Determine the flow rates and molar compositions of the two resulting product streams.
2. Create a case study to see the effect of changing temperature of the cooler out stream on the molar flow of the liquid product stream, and write your comment. (Use range: from -30 to 30°C with step size =5°C)

Exercise 03: (Use Amine Pkg Fluid Pkg)

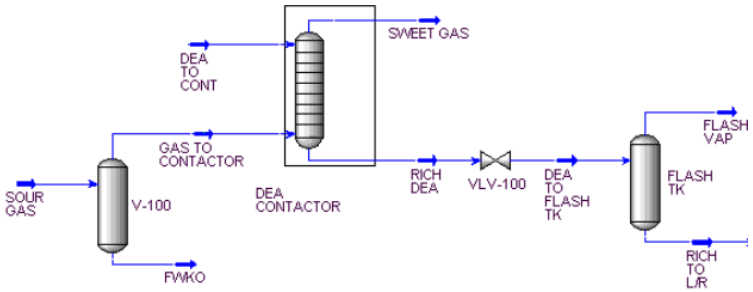


Figure 2 Process flow schematic Exercise 02

The simulation models an acid gas treatment process using Aspen HYSYS to remove CO_2 and H_2S from natural gas, with diethanolamine (DEA) employed as the absorption medium. The process begins with the introduction of acid gas into the system at 86 °F and 1000 psia, with a molar flow rate of 25 MMSCFD (Table 1). Free water is first removed in a separator operating with negligible pressure drop, and the vapor stream exiting this separator is directed to a 20-stage absorption column (DEA Contactor). The absorber operates at a pressure of 995 psia at the top and 1000 psia at the bottom, with corresponding temperatures of 100 °F and 160 °F, respectively. A lean DEA solution, consisting of 27.95 wt% DEA, 71.87 wt% H_2O, and 0.18 wt% CO_2, is fed to the column at 95 °F and 995 psia, with a molar flow rate of 1086 kgmol·h^{-1}. Within the column, CO_2 and H_2S are absorbed into the DEA solution, producing treated (sweet) gas at the top outlet and a rich amine solution (RICH DEA) at the bottom outlet. The rich DEA solution is subsequently depressurized to 90 psia through a control valve and then fed to a second separator, where hydrocarbons and dissolved gases are removed and discharged as a flash vapor stream (FLASH VAP).

1. Summarize the objective of this simulation.
2. Determine the fractions of acid gas components (CO_2, H_2S, and DEA–amine) at the inlet and at the two outlet streams of the absorption column (DEA Contactor)

Subject: Process engineering Simulations: Aspen hysys Grade: 1st MGP

Academic Year: 2024-2025 Date : 15/01/2026

Final Exam

Exercise 01: (Use SRK Fluid Pkg)

1. Present the process flow schematics

2 pt

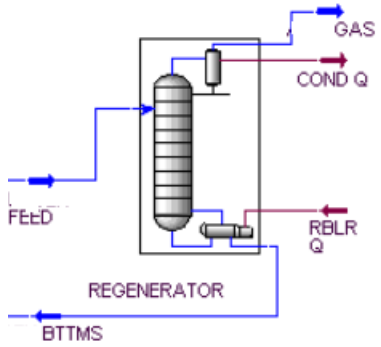


Figure 1 Process flow shematic Exercise 01

2. Report the composition of the distillation column outlet streams.

3 pt

	GAS	BTTMS
Ethane	0.1325	0.00018
Propane	0.8135	0.0208
n-Butane	0.0531	0.4623
n-Pentane	0.0001	0.4522
n-Hexane	0.00005	0.0642

3. Compare the condenser and reboiler temperatures, as well as the reflux ratio, before and after the modification

3 pt

	Before	After
Condenser temperature	49.08°C	46.04°C
reboiler temperature	127.9°C	128.7°C
reflux ratio	6.06°C	9.39°C

Exercise 02: (Use Peng Robinson Fluid Pkg)

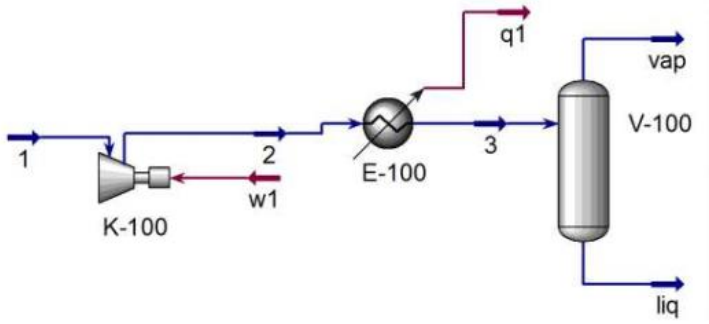


Figure 2 Process flow schematic Exercise 02

1. Determine the flow rates and molar compositions of the two resulting product streams.

3 pt

	Liq	Vap
Ethane	0.0727	0.4018
Propane	0.1852	0.2483
i-Butane	0.6828	0.3302
n-Butane	0.0593	0.0197

2. Create a case study to see the effect of changing temperature of the cooler out stream on the molar flow of the liquid product stream, and write your comment. (Use range: from -30 to 30°C with step size =5°C)

3 pt

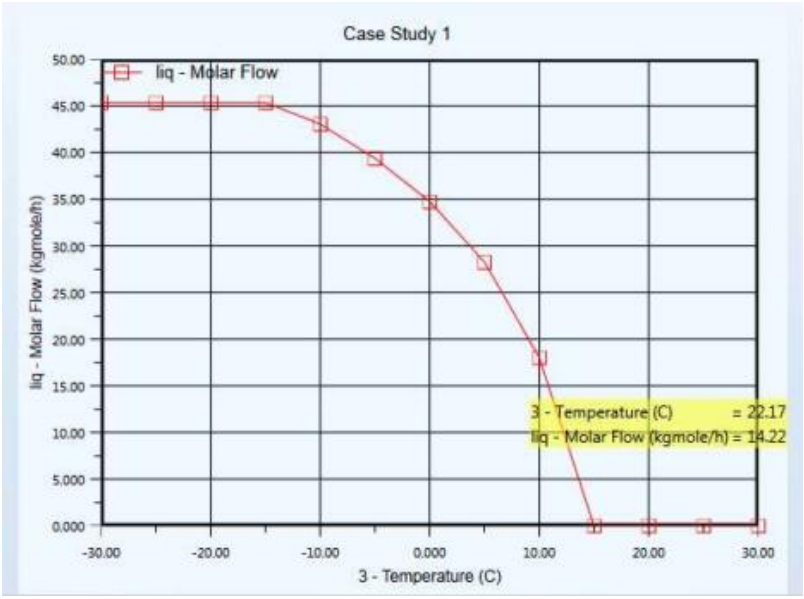


Figure 3 effect of changing temperature of the cooler out stream on the molar flow of the liquid product stream

Exercise 03: (Use Amine Pkg Fluid Pkg) (6 points)

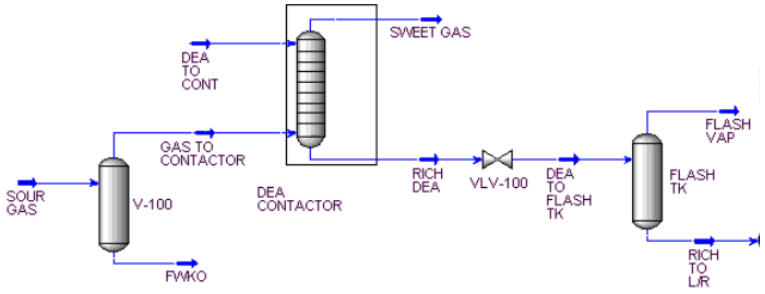


Figure 4 Process flow schematic Exercise 02

1. Summarize the objective of this simulation. **……(3 pt)**

The simulation models an acid gas treatment process using Aspen HYSYS to remove CO_2 and H_2S from natural gas with diethanolamine (DEA) as the absorption medium, producing treated gas and a rich DEA solution for further processing.

2. Determine the fractions of acid gas components (CO_2, H_2S, and DEA–amine) at the inlet and at the two outlet streams of the absorption column (DEA Contactor)

3 pt

	Sweet gaz	**Rich DEA**
CO_2	0.00191	0.2483
H_2S	0.0016	0.1331
DEA-Amine	0	0.2924

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جـــامعة العربي بن مهيـدي-أم البـواقي-

Subject: python Advanced Programming — Level : 1st Master GPC

Academic Year: 2025-2026 — Date : 13/01/2026

Python Advanced Programming: Final Exam

Exercise 01:

Complete the Python program below to calculates the total energy consumption of a distillation column $Q_{total} = \sum Q_i$. The program should ask the user for the number of column units (such as reboilers or condensers), then for each unit request its name and energy duty in kilowatts (kW). Store this information as a list of dictionaries. Create a function called total_distillation_energy(**kwargs) that receives this list as a keyword argument, prints the energy duty of each unit in a formatted summary, and computes and displays the total energy requirement of the distillation column with two decimal places.

```
def total_distillation_energy(**kwargs):
    units = _______.[ "units"]
    total_Q = 0
    print("\n--- DISTILLATION COLUMN ENERGY SUMMARY ---")
    for u in _____:
        print(f"{u['name']}: {u['duty']:.2f} kW")
        ____________
    print(f"\nTotal Column Energy = {total_Q:.2f} kW")

# --- Main Program ---
n = int(input("Enter number of column units (Reboiler, Condenser, etc.): "))
units = [ ]
for i in range(____):
    ____________________________________________
    ____________________________________________
    units.append({"name": name, "duty": duty})
total_distillation_energy(units=units)
```

Exercise 02:

Write a Python program that calculates the Log Mean Temperature Difference (LMTD) and the heat transfer rate of a heat exchanger. The program must include a function that calculates the LMTD using the formula

$$\text{LMTD} = \frac{\Delta T_1 - \Delta T_2}{\ln(\Delta T_1 / \Delta T_2)} \quad \text{where } \Delta T_1 = T_{h,in} - T_{c,out} \text{ and } \Delta T_2 = T_{h,out} - T_{c,in}.$$

The function should first check that both temperature differences are positive before performing the calculation, and must handle the special case where the temperature differences at both ends are equal to avoid a "division by zero" error.

The program must also include a second function that computes the heat transfer rate using the equation

$$Q = U \times A \times \text{LMTD}$$

where U is the overall heat transfer coefficient and $A$is the heat transfer area.

The program should ask the user to enter all required temperatures, the heat transfer coefficient, and the heat transfer area, then display the calculated LMTD and heat transfer rate. Finally, the program should allow the user to repeat the calculation until they decide to stop.

الجمهورية الجزائرية الديمقراطية الشعبية
République Algérienne Démocratique et Populaire
وزارة التعليم العالي و البحث العلمي
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Université Larbi Ben M'hidi - Oum El Bouaghi-
جـــامعة العربي بن مهيـدي-أم البـواقي-

Subject: python Advanced Programming — Level : 1st Master GPC

Academic Year: 2025-2026 — Date : 13/01/2026

Python Advanced Programming: Final Exam

Exercise 01:

```
def total_distillation_energy(**kwargs):
    units = kwargs[ "units"]…… (1 pt)
    total_Q = 0
    print("\n--- DISTILLATION COLUMN ENERGY SUMMARY ---")
    for u in units: ……(1 pt)
        print(f"{u['name']}: {u['duty']:.2f} kW")
      total_Q += u['duty']……(1 pt)
    print(f"\nTotal Column Energy = {total_Q:.2f} kW")

# --- Main Program ---
n = int(input("Enter number of column units (Reboiler, Condenser, etc.): "))
units = [ ]
for i in range(n): ……(1 pt)
   name = input(f"Enter name of unit {i+1}: ")……(1 pt)
   duty = float(input("Enter energy duty (kW): "))……(1 pt)
    units.append({"name": name, "duty": duty})
total_distillation_energy(units=units)
```

Exercise 02:

1. importing the input data (th_in, th_out, tc_in, tc_out, U, A) ……..(4 pt)
2. Verifying that all entries consist of numerical values using the .isdigit() function before converting them to float type. ……(2 pt)
3. Checking that ΔT_1 and ΔT_2 meet the necessary criteria: both values must be negative, and ΔT_1 should not equal ΔT_2.…… …….(2 pt)
4. Defining the LMDT and Q functions with accurate return values. ……(4 pt)
5. Displaying the results. ……(1 pt)
6. Enclosing the entire program within a while loop, ensuring proper termination conditions to conclude the program……(1 pt)

```
import math
def calculate_lmtd(th_in, th_out, tc_in, tc_out):
    dt1 = th_in - tc_out
    dt2 = th_out - tc_in

    if dt1 <= 0 or dt2 <= 0:
        print( "Error: Temperature differences must be positive.")
    elif dt1 == dt2:
        print ("Warning: Temperature differences are equal. The LMTD is undefined
in this case.")
    else:
        LMDT= (dt1 - dt2) / math.log(dt1 / dt2)
        print(f'Calculated LMTD: {LMDT:.2f} °C')
        return LMDT

# 2. Function to calculate Heat Loss
def calculate_heat(U, A, LMDT):
    if LMDT is not None:
        Q = U * A * LMDT
        print(f'Calculated Q: {Q:.2f} °C')
    else:
        print('Error Q cant be Calculated : ')
active = True
while active:
    print("\n--------- Heat Exchanger Analysis ------")
    print("\n--------- Pease entre the Data for LMDT & Heat calculations ------")
    th_in = input("Please entre the Hot inlet Temperature (°C): ")
    th_out = input("Please entre the Hot outlet temperature (°C): ")
    tc_in = input("Please entre the Cold inlet Temperature (°C): ")
    tc_out = input("please entre the Cold outlet Temperature (°C): ")
    U = input('Please entre the Heat transfert Coef (W.m².K): ')
    A= input('Please entre the heat transfert Area (m²): ')
    if th_in.isdigit() and th_out.isdigit() and tc_in.isdigit() and
tc_out.isdigit() and U.isdigit() and A.isdigit():
        th_in=float(th_in)
        th_out=float(th_out)
        tc_in=float(tc_in)
        tc_out=float(tc_out)
        U=float(U)
        A=float(A)
        LMDT=calculate_lmtd(th_in,th_out,tc_in,tc_out)
        calculate_heat(U,A,LMDT)

    choice = input("\nPerform another calculation? (y/n): ")
    if choice.lower() != 'y':
```

Corrigé type (MPD)

Exercice 1: (10)

a) Δp ? ; $\Delta p = \frac{\lambda H . Sp w_0 . \rho}{8 \varepsilon^3}$, $\lambda = f(Re)$ (0,75)

$Re = \frac{4 w_0 . \rho}{Sp . \mu}$ on a aussi $w_0 = \frac{v}{F.t}$ et $v = \frac{G}{\rho}$ (0,75)

$\Rightarrow v = 2000\ m^3/h \Rightarrow w_0 = 0,463\ m/s$ (1,5)

donc $Re = 75,1 \Rightarrow RT \Rightarrow \lambda = \frac{11,6}{Re^{0,2}} \Rightarrow \lambda = 3,94$ (2)

$\varepsilon = \frac{Sp . de}{4} \Rightarrow \varepsilon = 0,54$ (1,75)

$\Delta p = 226,3\ N/m^2$ (0,5)

Exercice 2: (10)

a) w_0' ? et w ? ; $w_0' = \frac{Re_0' . \mu}{dp . \rho}$; $Ar = \frac{dp^3 . \rho (\rho_p - \rho) g}{\mu^2}$

$Ar = 3,457\,10^5$, $\psi = \frac{\phi^3 . \varepsilon_0^3}{(1-\varepsilon_0)^2} \Rightarrow \psi = 0,178$ (2,5)

$\psi Ar = 61459 \Rightarrow Re_0' = 0,27 \frac{(1-\varepsilon_0)(\psi . Ar)^{0,67}}{\phi} \Rightarrow Re_0' = 88,51$ (1,5)

$\Rightarrow w_0' = 2,06 m/s$ et on a $\Delta = \frac{w}{w_0} \Rightarrow w = 3,3 m/s$

b) $R = \frac{H}{H_0} = \frac{(1-\varepsilon_0)}{(1-\varepsilon)}$ et on a $\varepsilon = \left\{ \frac{18 Re + 0,36 Re^2}{} \right\}^{0,21}$

$Re = \frac{w . dp . \rho}{\mu} \Rightarrow Re = 141,8$ (1,5) ; $\varepsilon = 0,47$ (0,75)

$R = 1,13$ (0,5)

$H = H_0 \frac{(1-\varepsilon_0)}{(1-\varepsilon)} \Rightarrow H = 0,439\ m$ (1,25)

$\Delta p_m = H(\rho_p - \rho) g (1-\varepsilon) \Rightarrow \Delta p = 3,194\,10^3\ N/m^2$ (0,5)

Corrigé type : techniques d'analyse

Exercice N°1 (8 pts)

Les deux effets sont : effet bathochrome et hyperchrome

Calcul de λ_{max}

$\lambda_{max\ 1} = 309$ nm

$\lambda_{max2} = 289$ nm

$\lambda_{max3} = 353$ nm

Exercice N°2 (5 pts)

Spectre N°1 ; Acide éthanoïqueprésence d'une bande forte vers 2500-3200 Cm^{-1} due à la liaison OH une autre bande forte vers 1680-1710 Cm^{-1} due à la liaisonC=O.

Spectre N°2 : Acétoneprésence d'une bande forte vers 1650-1730 Cm^{-1} due à la liaison C=O.

Spectre N°3 : Ethane présence d'une bande forte vers 2800-3000 Cm^{-1} due à la liaison C-H.

Spectre N°4 : Ethylamine présence d'une bande forte vers 3100-3500 Cm^{-1} due à la liaison N-H une autre bande moyenne vers 1560-1640 Cm^{-1} due à la liaison N-H.

Spectre N°5 : Ethanol présence d'une bande forte vers 3200-3400 Cm^{-1} due à la liaison OH.

Exercice N°3 (7 pts)

Calcul des facteurs de capacité

$k' = t'_r / t_m$ $k'_t = 3$ $k'_E = 4.6$

Calcul de la sélectivité α

$\alpha = k'_E / k'_t = 1{,}53$

Calcul de la résolution R_s

$R_s = 2.(t'_{rE} - t_{rt}) / \omega_1 + \omega_2 = 3{,}55$

On a $R_s > 1.5$ donc on a une bonne séparation

Calcul du nombre de plateaux

$N = 16 (t_r / \omega) = 2007$

Pour améliorer la séparation on peut changer la polarité des deux phases ou la longueur de la colonne.

Remarque : concernant les questions théoriques voir le cours.

Model Answers: Electrochemistry 3GPC

Exercise 1 (11p)

1. Operating Principle of a Concentration Cell.
A concentration cell operates due to a **difference in concentration** of the same metal ion (here, Pb^{2+}) in two otherwise identical half-cells. The system spontaneously evolves to **equalize these concentrations**. Oxidation (dissolution of the metal) occurs in the more dilute half-cell, increasing the local [Pb^{2+}]. Reduction (plating of the metal) occurs in the more concentrated half-cell, decreasing the local [Pb^{2+}]. The electric current is generated by this difference in chemical activity.

2. Detailed Diagram of the Cell.

3. Why a current is delivered with a single redox couple.
Although the redox couple Pb^{2+}/Pb is the same, the **electrochemical potential** of each electrode differs due to the different ion concentrations, as described by the **Nernst equation**: $E = E° + (RT/nF) \ln([Pb^{2+}])$. The half-cell with the higher [Pb^{2+}] has a higher (less negative) potential. This **difference in potential** creates the electromotive force (e.m.f.) that drives the current.

4. Calculate the initial e.m.f. at 298 K.

- For the **concentrated half-cell** ([Pb^{2+}] = 0.10 M):
  E□ = -0.13 + (0.059/2) * log□□(0.10) ≈ -0.13 - 0.0295 = -0.1595 V
- For the **dilute half-cell** ([Pb^{2+}] = 0.0010 M):
  E□ = -0.13 + (0.059/2) * log□□(0.0010) ≈ -0.13 - 0.0885 = -0.2185 V
- The cell e.m.f. (ΔE) is: E(cathode) - E(anode) = E□ - E□ = (-0.1595) - (-0.2185) = +0.0590 V.

5. Calculations for charge (Q) and lead mass.

- **Charge delivered (Q)**: $Q = I \times \Delta t = 0.15\ A \times (2.5 \times 3600\ s) = 0.15\ A \times 9000\ s = 1350\ C$
- **Moles of electrons**: $n(e^-) = Q / F = 1350\ C / 96500\ C \cdot mol^{-1} \approx 0.0140\ mol$
- **Reaction at the anode (where [Pb^{2+}] increases)**: $Pb(s) \rightarrow Pb^{2+}(aq) + 2e^-$. Thus, 2 moles of e^- correspond to 1 mole of Pb oxidized.
- **Moles of Pb oxidized**: $n(Pb) = n(e^-) / 2 = 0.0140 / 2 = 0.00700\ mol$
- **Mass of Pb oxidized**: $m(Pb) = n(Pb) \times M(Pb) = 0.00700\ mol \times 207.2\ g \cdot mol^{-1} \approx 1.45\ g$

Answer: Q = 1350 C; mass of lead oxidized ≈ 1.45 g.

6. Evolution of [Pb^{2+}] in relation to e.m.f.
The **initial concentration difference** creates the initial e.m.f. (59 mV). As the cellloperates:

- [Pb^{2+}] **increases** in the dilute anode compartment.
- [Pb^{2+}] **decreases** in the concentrated cathode compartment.

This **reduces the concentration gradient**. According to the Nernst equation, as the ratio [Pb^{2+}]_conc / [Pb^{2+}]_dil approaches 1, the e.m.f. **continuously decreases**. The process stops spontaneously when the concentrations equalize, at which point the e.m.f. drops to **0 V**.

Exercise 2(09p)

Since chlorine $Cl_2(aq)$ acts both as the oxidizing agent of the redox couple Cl_2/Cl^- and as the reducing agent of the couple $HClO/Cl_2$, the following disproportionation equilibrium can be written:
$Cl_2(aq) + H2O \rightleftharpoons HClO(aq) + Cl^-(aq) + H^+$
To calculate the equilibrium constant, the equality of the Nernst potentials associated with the two redox couples must be written.

Redox couple Cl_2/Cl^-:
$Cl2(aq) + 2\ e^- \rightleftharpoons 2\ Cl^-(aq)$
$E = E1° + 0.03 \log([Cl2(aq)] / [Cl^-(aq)]^2)$
Redox couple $HClO/Cl_2$:
$2\ HClO(aq) + 2\ e^- + 2\ H^+ \rightleftharpoons Cl_2(aq) + 2\ H_2O$
$E = E_2° + 0.03 \log([HClO(aq)]^2\ [H^+]^2 / [Cl_2(aq)])$
Thus:
$E1° + 0.03 \log([Cl2] / [Cl^-]^2) = E2° + 0.03 \log([HClO]^2\ [H^+]^2 / [Cl2])$
Hence:
$K = [HClO(aq)]\ [Cl^-(aq)]\ [H^+] / [Cl_2]$
$= 10^{((E1° - E2°) / 0.06)}$
$K = 10^{(-11/3)} = 2.15 \times 10^{-4}$
The reaction balance is therefore:
$Cl_2(aq) + H_2O \rightleftharpoons HClO(aq) + Cl^-(aq) + H^+$
Initial state:
$[Cl_2] = 0.05\ mol \cdot L^{-1}$
$[HClO] = 0.05\ mol \cdot L^{-1}$
$[Cl^-] = 0$
$[H^+] = 0.01\ mol \cdot L^{-1}$
Equilibrium state:
$[Cl2] = 0.05 - x$
$[HClO] = 0.05 + x$
$[Cl^-] = x$
$[H^+] = 0.01$
Note: the hydrogen ion concentration remains constant and equal to$[H^+] = 0.01\ mol \cdot L^{-1}$ since the solution is buffered at pH = 2.
Thus:
$K = (0.01\ (0.05 + x)\ x) / (0.05 - x)$
Solving this second-degree equation gives:
$x = 1.28 \times 10^{-2}\ mol \cdot L^{-1}$
Therefore:
$[HClO(aq)] = 6.28 \times 10^{-2}\ mol \cdot L^{-1}$
$[Cl2(aq)] = 3.72 \times 10^{-2}\ mol \cdot L^{-1}$
$[Cl^-(aq)] = 1.28 \times 10^{-2}\ mol \cdot L^{-1}$
$[H^+] = 1.0 \times 10^{-2}\ mol \cdot L^{-1}$
The Nernst potential can be calculated using either of the following expressions:
$E = E1° + 0.03 \log([Cl_2] / [Cl^-]^2)$
$E = E2° + 0.03 \log([HClO]^2\ [H^+]^2 / [Cl_2])$
$E = 1/2\ (E1° + E2°) + 0.03 \log([HClO][H^+] / [Cl^-])$ (overall system)
Final result:
$E = 1.466\ V$

Typical correction -Regulations and Standards

Question 1 (4 points)

Give the definition of the following terms

1. Regulations (with example)…… (0, 50).

Regulations are mandatory legal rules established by public authorities (government) to protect health, safety, and the environment. Compliance is obligatory.

Example:……(0,25).
Food safety regulations that require labeling of allergens on food products.

2. Standard (with example) …… (0, 50).

A standard is a document approved by a recognized body that provides rules, guidelines, or characteristics for products, processes, or services. Standards are generally voluntary.

Example:……(0,25).
ISO 9001 standard for quality management systems.

3. Accreditation (with example) …… (0, 50).

Accreditation is the formal recognition that an organization (such as a laboratory or certification body) is competent to perform specific conformity assessment activities.

Example:……(0,25).
COFRAC.

4. AFNOR…… (0, 50).

AFNOR (Association Française de Normalisation) is the French national standardization body, responsible for developing and publishing standards in France.

5. EN ISO 9001…… (0, 25).

EN ISO 9001 is a European adoption of the international ISO 9001 standard, specifying requirements for a Quality Management System (QMS).

6. EN 71…… (0, 25).

EN 71 is a European standard related to the safety of toys, defining mechanical, physical, and chemical safety requirements.

7. ISO 22000…… (0, 25).

ISO 22000 is an international standard that specifies requirements for a Food Safety Management System to ensure food safety along the supply chain.

8. ISO 14001…… (0, 25).

ISO 14001 specifies requirements for an Environmental Management System (EMS) to help organizations reduce environmental impacts.

9. ISO 50001…… (0, 25).

ISO 50001 is an international standard for Energy Management Systems, aiming to improve energy performance and efficiency.

Typical correction -Regulations and Standards

Question 2 (8 points)

1. Role of standards in ensuring product and service quality Standards ensure quality by: …… (1.00).

- Defining clear technical and performance requirements
- Improving consistency and reliability
- Enhancing customer satisfaction
- Ensuring safety and compliance

2. Why must standards be periodically reviewed? …… (1.00).

Standards must be reviewed to:

- Adapt to technological progress
- Reflect market and consumer needs
- Improve safety and efficiency
- Remain relevant and effective

3. Steps for adopting an international standard…… (2.00).

1. Proposal of a new standard
2. Drafting by technical committees
3. Public consultation and comments
4. Voting by ISO member countries
5. Publication of the standard

4. Difference between international and European standards

- **International standards (ISO)** apply worldwide……(1.00).
- **European standards (EN)** apply within Europe……(1.00).

Example of a European standard:

EN 71 (Safety of toys) …… (0.75).

5. Principles of standardization…… (1.25).

- Transparency
- Consensus
- Voluntary application
- Openness
- Technological neutrality

Typical correction -Regulations and Standards

Question 3 (8 points)

1. Difference between Certification and Accreditation…… (2.00).

- **Certification:** Confirms that a product, system, or organization complies with a standard
- **Accreditation:** Confirms that a certification or testing body is competent to perform certification

2. If a company is ISO 9001 certified, is it accredited? Why?

No. …… (0.50).
Certification applies to organizations, while **accreditation applies to certification bodies**, not companies. **…… (1.00).**

3. What is an ISO standard and its role in certification and accreditation?

An ISO standard is an **international reference document** used as a basis for:

- Certification of organizations
- Accreditation of certification bodies**…… (2.00).**

4. Country and mission of COFRAC

- **Country:** France**…… (0.50).**
- **Mission:** To accredit testing laboratories, inspection bodies, and certification bodies, ensuring their competence and impartiality. **…… (0.50).**

5. Example of a laboratory benefiting from COFRAC accreditation…… (0.50).

- Medical analysis laboratory
- Food testing laboratory
- Environmental testing laboratory

6. Short description of IANOR…… (1.00).

The **Algerian Institute for Standardization (IANOR)** is the national body responsible for **standardization, certification, and promotion of quality** in Algeria. It represents Algeria in international standardization organizations such as ISO.

Typical correction - Agro-Food processes

Question 01 (7 points)

1. **Definition of food preservation and its objectives** ……(0,50)

   Food preservation is the set of techniques used to prevent or slow down food deterioration in order to extend shelf life.

2. **Objective:** ……(0,50)
   - Inhibit microbial growth
   - Reduce enzymatic and chemical reactions
   - Maintain nutritional value, safety, and sensory quality

1. **Chemical vs physical preservation methods**……(1,00)

- **Chemical preservation:** Uses chemical substances to inhibit microorganisms.
  Examples: salt (salting), sugar (jam), preservatives such as sodium benzoate.
- **Physical preservation:** Uses physical processes to preserve food.
  Examples: heating (pasteurization), refrigeration, freezing, drying.

3. **Undesirable effects of heating food**……(1,00)
   - Loss of vitamins (especially vitamin C and B)
   - Changes in color, flavor, and texture
   - Protein denaturation
   - Formation of undesirable compounds

4. **4. Factors responsible for food deterioration**……(1,00)
   - Microbial: bacteria, yeasts, molds (e.g. milk spoilage)
   - Enzymatic: enzymatic browning in fruits
   - Chemical: oxidation of fats (rancidity)
   - Physical: moisture loss, temperature abuse

5. **5. Importance of immediate cooling after production**……(0,50)
   - **Immediate cooling** slows microbial growth, reduces enzymatic activity, and prevents spoilage in sensitive foods such as milk, meat, and cooked meals.

1. **6. Difference between refrigeration and freezing…….(1,00)**

- **Refrigeration:** Storage at 0–4 °C; slows microbial growth.

Freezing: Storage below −18 °C; stops microbial growth and enzymatic activity.

7. Why dehydration prolongs shelf life

Dehydration removes water needed for microbial growth and enzymatic reactions, thus preventing spoilage.

1. **8. Pasteurization vs sterilization…….(1,00)**

Pasteurization: Destroys pathogenic microorganisms but not spores.

Sterilization: Destroys all microorganisms, including spores.

1. **9. Most resistant bacteria to pasteurization…….(0,50)**

Spore-forming bacteria such as Bacillus and Clostridium.

Question 02 (6points)

1. **1. Types of storage in the food industry…….(1,00)**

- Ambient storage
- Refrigerated storage
- Frozen storage
- Controlled atmosphere storage

2. **2. Risks of improper food storage…….(0,50)**

- Microbial contamination
- Food poisoning
- Quality loss
- Economic losses

3. Main steps of the cold chain

1. Production → Cooling → Refrigerated transport → Cold storage → Distribution → Consumer**…….(1,00)**

1. 4. Role of conditioning…….(0,50)

Conditioning protects food from external factors (air, moisture, light) and facilitates handling and storage.

1. 5. Packaging vs conditioning…….(1,00)

Packaging: The material used to contain food.

Conditioning: The overall process of protecting and preparing food for storage and distribution.

6. Example

- **Packaging:** Plastic bottle for milk…….**(0,50)**
- **Conditioning:** Bottling and labeling of milk…….**(0,50)**

7. Why dehydration prolongs shelf life

Dehydration removes water needed for microbial growth and enzymatic reactions, thus preventing spoilage. **……. (1,00)**

Question 03 (7 points)

1. Coagulation vs gelation…… (1,00)

Coagulation: Protein aggregation forming a solid mass (e.g. milk curd).

Gelation: Formation of a three-dimensional network trapping water (e.g. gelatin).

2. Factor causing milk coagulation…… (0,50)

- Acidification
- Enzymes (rennet)
- Heat

4. Two types of fermentation…… (1,00)

Alcoholic fermentation: produces ethanol and CO_2

Lactic fermentation: produces lactic acid

5. Types of filtration…… (1,50)

Gravity filtration: slow, uses gravity

Vacuum filtration: faster, uses reduced pressure

Pressure filtration: uses applied pressure for viscous liquids

6. Natural emulsifiers…… (0,75)

- Lecithin (egg yolk)
- Proteins (milk proteins)
- Gums (gum arabic)

7. Stable emulsion without emulsifier? ..... (0,75)

No. Without an emulsifier, droplets coalesce due to high interfacial tension, causing phase separation.

8. Factors influencing emulsion stability..... (0,50)

- Droplet size
- Type and concentration of emulsifier
- Temperature

9. Steps in preparing an emulsion (mayonnaise) ..... (1,00)

- Mixing egg yolk and emulsifier
- Slow addition of oil with agitation
- Homogenization
- Seasoning